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⑯ Stabilized polymorphic form of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl) acrylamide and the process for its preparation.

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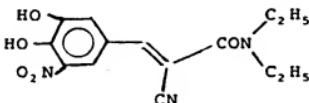
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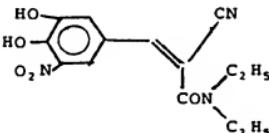
**Description**

The present invention relates to the stable and crystallographically essentially pure polymorphic form of N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide E-isomer, denoted (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide A, and to a process for the preparation thereof.

N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide described in GB-A-2200109 is a potent inhibitor of catechol-O-methyl-transferase enzyme (COMT) and may be used pharmaceutically in the treatment of e.g. Parkinson disease. This compound with melting point 153-156 °C has proved to be a mixture of two geometric isomers; E- and Z-isomers (70-80% E-isomer and 30-20% Z-isomer) having formulae:



20 E-isomer, m.p. 162 - 163 °C



30 Z-isomer, m.p. 148 - 151 °C (E)-N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide(I) may exist at least in two polymorphic forms A and B as shown by X-ray crystallography. The Z-isomer as well as the polymorphic form B of the E-isomer have been shown to be unstable. The Z-isomer is transformed readily into the E-isomer on the influence of heat or acids. Similarly the polymorphic form B of the E-isomer isomerises slowly to the polymorphic form A on standing at room temperature. On recrystallization of the crude synthesis product from conventional solvents such as lower aliphatic alcohols, esters or hydrocarbons, e.g. ethanol, 2-propanol, ethyl acetate or toluene, a very complicated mixture of different 40 geometric isomers and/or polymorphic forms are generally obtained which interfere with the characterization and standardization of the drug substance. The polymorphism and geometrical isomerism may also influence on the bioavailability of the drug.

Surprisingly it has now been observed that crystallographically essentially pure and stable polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide is obtained in good yield, when 45 the crude product of synthesis is recrystallized from a lower aliphatic carboxylic acid such as formic or acetic acid with a catalytic amount of hydrochloric or hydrobromic acid added. This method allows large scale production of homogenous and crystallographically essentially pure polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide independent of batch size or cooling rate.

"Crystallographically essentially pure" means here the polymorphic form A of (E)-N,N-diethyl-2-cyano-50 3-(3,4-dihydroxy-5-nitrophenyl)acrylamide containing a maximum of 3% and preferably a maximum of 2% of other polymorphic forms or Z-isomer.

"Lower aliphatic carboxylic acid" means here aliphatic carboxylic acid having 1-2 carbon atoms. Examples are formic and acetic acid.

The amount of hydrochloric or hydrobromic acid appropriate for use in crystallising the crude form of 55 the product will vary depending on the exact proportion of isomers in the crude form. Typically hydrobromic acid will be used in a weight ratio of hydrobromic acid: carboxylic acid of 1:80 to 1:120, preferably about 1:100. Typically hydrochloric acid will be used in a weight ratio of hydrochloric acid: carboxylic acid of 1:180 to 1:220, preferably about 1:200.

The crystallization from the crude product takes place preferably by first admixing the crude product and the carboxylic acid and the hydrohalic acid in any order. Most conveniently the hydrohalic acid is first admixed with the carboxylic acid and the crude product then added, although other processes, e.g. the simultaneous admixing of the three components, is also envisaged.

5 The crude product is preferably used in a weight ratio of crude product to carboxylic acid of 1:1.5 to 1:4 more preferably 1:2 to 1:3.

10 The mixture is generally heated, preferably with stirring, to a temperature at which the crude product dissolves but below the boiling point of the mixture. Typically this is 80 to 98°C e.g. about 90°C. The solution is then slowly cooled to about 15-20°C and the crystalline product, essentially pure polymorphic form A, may be filtered and washed.

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Table 1. Typical IR-absorption bands of the polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide

	Wavenumbers ( $\text{cm}^{-1}$ ) and the relative intensities of absorption bands	Assignment of the vibrational modes
10	3339 s	O-H stretching
	3092 w	C-H stretching, aromatic and unsaturated
	3066 w	
	3039 w	
15	2981 w	C-H stretching, saturated
	2938 w	
	2217 m	CN stretching
20	1628 s	tertiary amide C=O stretching
	1607 s	
	1580 sh	C=C stretching, conjugated with C=O and aromatic ring; and C-C stretching, aromatic
25		
	1544 s	NO <sub>2</sub> asymmetric stretching
30	1512 m	C=C stretching, aromatic
	1441 s	CH <sub>3</sub> bending; asymmetric CH <sub>3</sub> bending; C=C stretching, aromatic
35	1377 s	NO <sub>2</sub> symmetric stretching; OH bending
40	1298 s	C-O stretching
	1281 sh	
	1210 m	C-H bending, aromatic
	1165 m	
45	1150 m	
	800 sh	C-H out of plane bending, aromatic
	779 m	
	740 m	

s = strong; m = medium; w = weak; sh = shoulder

## Experimental

5	Instrument:	Perkin-Elmer FTIR 1725X
	Detector:	TGS
	Ordinate mode:	%T
	Abscissa mode:	Wavenumbers (cm <sup>-1</sup> )
10	Resolution:	4 cm <sup>-1</sup>
	Number of scans:	20
	Phase	KBr

The X-ray powder diffraction patterns of the polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide are seen in Figure 2 and the crystallographic data in Table 2.

Table 2. Crystallographic data of polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide

Peak positions ( $2\theta$ ), interplanar spacings (d) and relative peak intensities of the first 20 reflections.

No	$2\theta$	d	Rel I (%)
1	3.680	23.9905	0.8
2	9.040	9.7745	49.7
3	11.840	7.4685	9.9
4	13.541	6.5339	11.1
5	14.060	6.2939	11.6
6	15.820	5.5974	7.6
7	16.320	5.4270	3.9
8	18.220	4.8651	4.6
9	18.459	4.8027	8.7
10	18.720	4.7363	13.6
11	18.940	4.6818	5.5
12	20.041	4.4270	5.0
13	20.380	4.3541	11.1
14	21.140	4.1993	3.5
15	21.939	4.0481	58.3
16	22.901	3.8802	13.8
17	23.340	3.8082	100.0
18	23.960	3.7110	3.3
19	24.480	3.6334	2.9
20	26.343	3.3805	3.6

## Experimental

Instrument:	Siemens D500
Wavelength:	0.1541 nm (CuK $\alpha_1$ )
Range:	3° - 33° (2θ)
Power:	40 mA/40 kV
Time:	1°/min (0.02°/step)

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The following example illustrates the invention.

Example 1.

15 The crude synthesis product (3.0 kg) prepared according to the method described in GB-A-2200109 was dissolved in 8.0 kg of acetic acid (98-100%) (or formic acid) containing 80 g of hydrogen bromide (or 40 g of hydrogen chloride) by heating to 90 °C. The solution was slowly cooled to 20 °C and stirred for 20 h at 20 °C and finally for 6 h at 15 °C. The crystalline product was filtered and washed carefully first with a cold (4 °C) mixture (1 l) of toluene-acetic acid (1:1 v/v) and then with cold toluene (1 l). The product was 20 dried in vacuum at 45 °C. Yield of crystallographically pure A form of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide was 2.4 kg (80%), m.p. 162-163 °C.

## Claims

## Claims for the following Contracting States : AT, BE, CH, DE, DK, FR, GB, IT, LI, LU, NL, SE

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1. The crystallographically essentially pure polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide characterized by the infrared spectrum in potassium bromide having the following absorption bands:

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Wavenumbers (cm $^{-1}$ )	Wavenumbers (cm $^{-1}$ )
3339	1512
3092	1441
3066	1377
3039	1298
2981	1281
2938	1210
2217	1165
1628	1150
1607	800
1580	779
1544	740

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2. A process for preparing the crystallographically essentially pure polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide of claim 1 which comprises crystallization of crude N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide from an aliphatic carboxylic acid having 1 or 2 carbon atoms containing a catalytic amount of hydrochloric or hydrobromic acid.
3. The process as claimed in claim 2, wherein said aliphatic carboxylic acid is acetic acid.
4. The process as claimed in claim 2, wherein said aliphatic carboxylic acid is formic acid.

## Claims for the following Contracting States : ES, GR

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1. A process for preparing the crystallographically essentially pure polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide characterized by the infrared spectrum in potassium bromide having the following absorption bands:

	WAVENUMBERS (cm <sup>-1</sup> )	WAVENUMBERS (cm <sup>-1</sup> )
5	3339	1512
	3092	1441
10	3066	1377
	3039	1298
	2981	1281
	2938	1210
	2217	1165
	1628	1150
15	1607	800
	1580	779
	1544	740

which comprises crystallization of crude N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide from an aliphatic carboxylic acid having 1 or 2 carbon atoms containing a catalytic amount of hydrochloric or hydrobromic acid.

- 20 2. The process as claimed in claim 1, wherein said aliphatic carboxylic acid is acetic acid.
- 3. The process as claimed in claim 1, wherein said aliphatic carboxylic acid is formic acid.

#### Patentansprüche

Patentansprüche für folgende Vertragsstaaten : AT, BE, CH, DE, DK, FR, GB, IT, LI, LU, NL, SE

- 25 1. Kristallographisch im wesentlichen reine polymorphe Form von (E)-N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)-acrylamid, dadurch gekennzeichnet, daß das Infrarot-Spektrum in Kaliumbromid die folgenden Absorptionsbanden aufweist:

	Wellenzahlen (cm <sup>-1</sup> )	Wellenzahlen (cm <sup>-1</sup> )
30	3339	1512
	3092	1441
35	3066	1377
	3039	1298
	2981	1281
	2938	1210
	2217	1165
40	1628	1150
	1607	800
	1580	779
	1544	740

- 45 2. Verfahren zur Herstellung der kristallographisch im wesentlichen reinen polymorphen Form von (E)-N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)-acrylamid nach Anspruch 1, welches die Kristallisation von rohem N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamid aus einer aliphatischen Carbonsäure mit 1 oder 2 Kohlenstoffatomen umfaßt, die eine katalytische Menge an Chlorwasserstoff- oder Bromwasserstoffsäure enthält.
- 3. Verfahren nach Anspruch 2, worin die genannte aliphatische Carbonsäure Essigsäure ist.
- 4. Verfahren nach Anspruch 2, worin die genannte aliphatische Carbonsäure Ameisensäure ist.

## Patentansprüche für folgende Vertragsstaaten : ES, GR

1. Verfahren zur Herstellung der kristallographisch im wesentlichen reinen polymorphen Form von (E)-N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)-acrylamid, dadurch gekennzeichnet, daß das Infrarot-Spektrum in Kaliumbromid die folgenden Absorptionsbanden aufweist:

	Wellenzahlen ( $\text{cm}^{-1}$ )	Wellenzahlen ( $\text{cm}^{-1}$ )
10	3339	1512
	3092	1441
	3066	1377
	3039	1298
	2981	1281
	2938	1210
15	2217	1165
	1628	1150
	1607	800
	1580	779
	1544	740

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welches die Kristallisation von rohem N,N-Diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamid aus einer aliphatischen Carbonsäure mit 1 oder 2 Kohlenstoffatomen umfaßt, die eine katalytische Menge an Chlorwasserstoff- oder Bromwasserstoffsäure enthält.

- 25 2. Verfahren nach Anspruch 1, worin die genannte aliphatische Carbonsäure Essigsäure ist.  
 3. Verfahren nach Anspruch 1, worin die genannte aliphatische Carbonsäure Ameisensäure ist.

## Revendications

30 Revendications pour les Etats contractants suivants : AT, BE, CH, DE, DK, FR, GB, IT, LI, LU, NL, SE

- 35 1. Forme polymorphe A essentiellement pure du point de vue cristallographique, de (E)-N,N-diéthyl-2-cyano-3-(3,4-dihydroxy-5-nitrophényl)acrylamide, caractérisée par un spectre infrarouge dans le bromure de potassium, présentant les bandes d'absorption suivantes :

	Nombres d'onde ( $\text{cm}^{-1}$ )	Nombres d'onde ( $\text{cm}^{-1}$ )
40	3339	1512
	3092	1441
	3066	1377
	3039	1298
	2981	1281
	2938	1210
	2217	1165
	1628	1150
	1607	800
	1580	779
	1544	740

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- 55 2. Procédé pour la préparation d'une forme polymorphe A essentiellement pure du point de vue cristallographique, de (E)-N,N-diéthyl-2-cyano-3-(3,4-dihydroxy-5-nitrophényl)acryamide selon la revendication 1, qui comprend la cristallisation du (E)-N,N-diéthyl-2-cyano-3-(3,4-dihydroxy-5-nitrophényl)-acrylamide brut à partir d'un acide carboxylique aliphatique comportant 1 ou 2 atomes de carbone contenant une quantité catalytique d'acide chlorhydrique ou d'acide bromhydrique.
3. Procédé selon la revendication 2, dans lequel ledit acide carboxylique aliphatique est l'acide acétique.

4. Procédé selon la revendication 2, dans lequel ledit acide carboxylique aliphatique est l'acide formique.

**Revendications pour les Etats contractants suivants : ES, GR**

5. Procédé pour la préparation de la forme polymorphique A essentiellement pure du point de vue cristallographique, de (E)-N,N-diéthyl-2-cyano-3-(3,4-dihydroxy-5-nitrophényl)acrylamide, caractérisée par un spectre infrarouge dans le bromure de potassium, présentant les bandes d'absorption suivantes :

10

Nombres d'onde (cm <sup>-1</sup> )	Nombres d'onde (cm <sup>-1</sup> )
3339	1512
3092	1441
3066	1377
15	3039
	1298
	2981
	1281
	2938
	1210
20	2217
	1165
	1628
	1150
	1607
	800
	1580
	779
	1544
	740

25 qui comprend la cristallisation du (E)-N,N-diéthyl-2-cyano-3-(3,4-dihydroxy-5-nitrophényl)acrylamide brut à partir d'un acide carboxylique aliphatique comportant 1 ou 2 atomes de carbone contenant une quantité catalytique d'acide chlorhydrique ou d'acide bromhydrique.

2. Procédé selon la revendication 1, dans lequel ledit acide carboxylique aliphatique est l'acide acétique.  
 30 3. Procédé selon la revendication 1, dans lequel ledit acide carboxylique aliphatique est l'acide formique.

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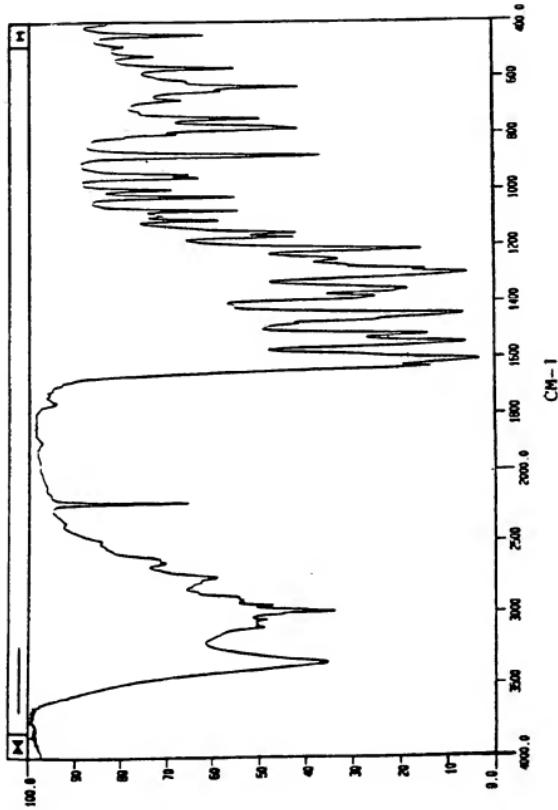


FIGURE 1. IR-spectrum of the polymorphic form A of  
(E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide.

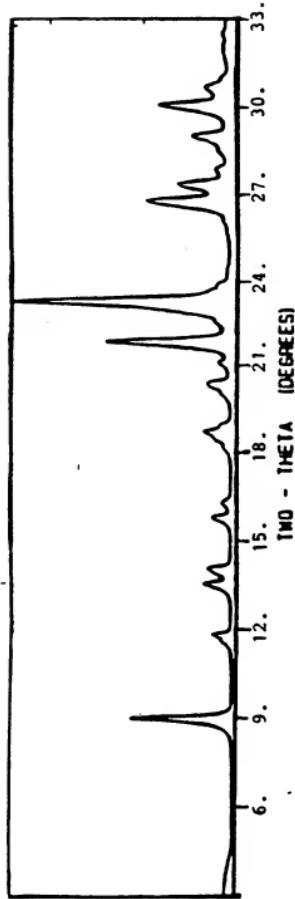


FIGURE 2. Standard X-ray powder diffraction pattern of the polymorphic form A of (E)-N,N-diethyl-2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylamide.